

Successful commercial computer programs such as the "Optimization Toolbox for use with Matlab" developed by The MathWorks Inc. can directly be used to solve the minimax problem as formulated in this invention without any difficulty (see the cited book "Optimization Toolbox User's Guide" authored by Coleman et al. and published by The MathWorks Inc.). The "Optimization Toolbox" and Matlab have been well known among people skilled in the art. It is easy for anyone skilled in the art to solve the minimax problem directly using the "Optimization Toolbox", the methods in the cited publications mentioned above, or any other method.

In the Claims:

Please replace all the old Claims 1-21 in record with new Claims 22-33 as follows:

We claim:

22. A method for determining the optimal tuning parameters in a linear controller, wherein
- 1) said controller receives an n-dimensional process variable signal $y(k)$ from a process and an n-dimensional set-point signal $r(k)$, calculates an m-dimensional controller output $u(k)$ according to a linear control equation, and sends said $u(k)$ to said process, where k is the integer discrete time variable and n and m are positive integers;
 - 2) said tuning parameters are the adjustable numbers in the coefficients in said linear control equation that are to be determined; and
 - 3) said method finds the optimal values for said tuning parameters by minimizing the maximum of absolute values of all poles of the discrete-time closed-loop transfer function from said set-point $r(k)$ to said process variable $y(k)$.
23. A method as in Claim 22, wherein said minimization of the maximum of absolute values of all poles of said discrete-time closed-loop transfer function is subject to user-specified constraints placed on one or more of said tuning parameters.
24. A method as in Claim 22, wherein said controller output $u(k) = u(k-1) + K_1 * r(k) * T + K_1 * a(k,1) + K_2 * a(k,2) + \dots + K_p * a(k,p)$, wherein k is the discrete time variable, $*$ is the multiplication operator, T is the sampling period, p is a positive integer, the m by n matrices K_1, K_2, \dots , and K_p are tuning parameters, $a(k,1) = [-y(k)] * T$, and $a(k,p) = [a(k,p-1) - a(k-1,p-1)] / T$ for $p > 1$.

25. A method as in Claim 23, wherein said controller output $u(k) = u(k-1) + K_1 * r(k) * T + K_1 * a(k,1) + K_2 * a(k,2) + \dots + K_p * a(k,p)$, wherein k is the discrete time variable, $*$ is the multiplication operator, T is the sampling period, p is a positive integer, the m by n matrices K_1, K_2, \dots , and K_p are tuning parameters, $a(k,1) = [-y(k)] * T$, and $a(k,p) = [a(k,p-1) - a(k-1,p-1)] / T$ for $p > 1$.
26. A method as in Claim 22, wherein said linear controller is a PID (proportional-integral- derivative) controller.
27. A method as in Claim 23, wherein said linear controller is a PID controller.
28. A linear controller as in Claim 22 with its tuning parameters determined therein.
29. A linear controller as in Claim 23 with its tuning parameters determined therein.
30. A linear controller as in Claim 24 with its tuning parameters determined therein.
31. A linear controller as in Claim 25 with its tuning parameters determined therein.
32. A PID controller as in Claim 26 with its tuning parameters determined therein.
33. A PID controller as in Claim 27 with its tuning parameters determined therein.

In the Abstract:

Please replace the Abstract in record with the new Abstract as follows:

-- Methods of designing optimal discrete-time PID (proportional-integral-derivative) controllers and linear controllers are disclosed. The optimal values of the tuning parameters in a PID controller or a linear controller are determined by minimizing the maximum of absolute values of all poles of the discrete-time closed-loop transfer function from the set-point to the process variable subject to, if any, user-specified constraints on one or more of the tuning parameters.--

In the Drawings:

Please add Figure 1 and Figure 2 as attached.